

## **ABSTRACT**

Biometric systems, designed to identify individuals through unique biological or behavioural characteristics, have become critical in modern security and identity verification applications. Finger vein authentication, which utilizes the unique vascular patterns within a person's finger, offers intrinsic security due to the internal and difficult-to-replicate nature of vein patterns. However, the accuracy and reliability of finger vein recognition systems are heavily influenced by the quality of feature extraction techniques and environmental factors, such as motion artifacts, lighting, and finger positioning.

This study focuses on developing a motion-tolerant deep learning model for finger vein recognition by employing advanced image labelling and dataset augmentation techniques. Traditional finger vein recognition systems rely on handcrafted features and classical machine learning algorithms, which face limitations in adaptability and accuracy under variable conditions. Recent advancements in deep learning have demonstrated the potential to automatically extract complex patterns from raw image data, addressing these challenges.

In the first phase, a modified UNET and VGG16 model are used for recognition and the performance have been compared on the benchmark datasets, SDUMLA-HMT and THUFV. The U-Net, originally developed for biomedical image segmentation, has been modified by incorporating a fully connected layer, extending its capabilities to include classification tasks. VGG16 outperformed UNET across multiple metrics, with its deep feature extraction capabilities enabling it to capture intricate vein patterns and achieve higher classification accuracy. VGG16 also demonstrated superior precision and recall, minimizing false negatives and improving robustness in practical applications.

The second phase explores the impact of using a hybrid labelling algorithm on the VGG16 model's performance. By accurately labelling finger vein images, the model is able to learn detailed vein patterns more effectively, leading to improved recognition accuracy and reduced overfitting. This phase emphasized the importance of creating diverse and representative datasets to enhance the model's generalization ability.

In the third phase, various dataset augmentation techniques are investigated, including conventional transformations (rotation, scaling, and flipping) and an advanced approach using Generative Adversarial Networks (GANs). The experimental results revealed that the

augmentation techniques significantly enhanced the diversity and quality of the training dataset, further improving the VGG16 model's recognition performance.

In the final phase, an adaptive finger vein recognition system that integrates VGG16 for feature extraction with Long Short-Term Memory (LSTM) for sequence learning has been developed. This motion-tolerant model is designed to handle real-world conditions, including motion artifacts and environmental variations, ensuring accurate recognition even when the finger is not perfectly still. The architecture was tested on the THUFV and SDUMLA-HMT datasets, demonstrated improvements in accuracy and robustness. This research demonstrates the effectiveness of combining VGG16 and LSTM architectures along with labelled and augmented dataset, to develop a reliable and scalable motion-tolerant finger vein recognition system. The findings contribute to the advancement of biometric authentication technologies, offering a robust solution for real-world applications.